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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	:	**Confirmation No. 6169**
Marc ROBELET	:	Docket No. 2003-1731A
Serial No. 10/726,651	:	Group Art Unit 3747
Filed December 4, 2003	:	Examiner Marguerite McMahon
METHOD OF MANUFACTURE OF A PISTON FOR AN INTERNAL COMBUSTION ENGINE, AND PISTON THUS OBTAINED	:	**MAIL STOP: AMENDMENT**

REQUEST FOR RECONSIDERATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

THE COMMISSIONER IS AUTHORIZED TO CHARGE ANY DEFICIENCY IN THE FEES FOR THIS PAPER TO DEPOSIT ACCOUNT NO. 23-0975

Sir:

In response to the Office Action of May 11, 2005, Applicant in the above-referenced U.S. patent application respectfully requests reconsideration.

Figure 1 has been labeled as prior art at this time in accordance with the requirement of the Examiner on page 2 of the Office Action. Please see the accompanying Submission of Replacement Drawing.

Claims 1-5 and 15 were rejected in the Office Action as being unpatentable over Kruse, U.S. Patent 6,286,414 (Kruse) in view of Tausig et al., U.S. Patent 6,311,759 (Tausig) or Uggowitzer et al., U.S. Patent 6,547,896 (Uggowitzer). Beginning at the bottom of page 3 of the Office Action, claims 6-14 and 16 were rejected as being unpatentable over these three references and in further view of Winter et al., U.S. Patent 4,457,355 (Winter). However, it is respectfully submitted that Kruse, Tausig, Uggowitzer and Winter do not render obvious the piston for an internal combustion engine and the method of manufacture of the piston for an internal combustion engine as claimed in claims 1-16.

As has been discussed previously, the present invention is directed to a piston for an internal combustion engine and a method of manufacturing the piston in which the piston is made

by heating a billet to an intermediate temperature between its solidus temperature and its liquidus temperature and then shaped by thixoforging to form the piston. This manner of making the piston makes it possible to make pistons for high-performance internal combustion engines by using a steel or other dense alloy that has high mechanical properties instead of a specially treated or shaped aluminum alloy, while providing a sufficiently reduced wall thickness after forging in order to provide a sufficiently low mass so as to obtain a high performance of the engine.

As discussed in the Background to the Invention, pistons are usually produced in one piece molded or forged aluminum alloy. However, increased stress conditions render such conventional pistons unsuitable. While various solutions have been proposed, these solutions are all quite expensive. The piston as a whole could be replaced with steel with comparable geometry, which would have a better resistance to mechanical and thermal stresses and to fatigue and better temperature resistance. However, because of the high density of the material, if the piston were given a sufficiently low mass in order to obtain high performance of the engine, it would be necessary to arrive at a very reduced wall thickness after forging of the piston. Such a thickness is not possible using conventional forging techniques if, for reasons of costs, it is desired to continue producing pistons in one piece. However, the present inventor has found that it is possible to manufacture a piston having such reduced wall thickness in one piece by using a thixoforging process.

As an initial matter, it is noted that the Examiner responds to Applicant's arguments beginning on page 4 of the Office Action by stating that the difference between thixocasting and thixoforging is not as clear-cut as has been presented. The Examiner refers to a discussion in column 1 of Tausig that "there seems to be some difficulty in literature and the industry in drawing a clear line between thixocasting and thixoforging processes." However, please note the immediately preceding discussion: "thixocasting is based on liquid metal die casting technology, where as thixoforging is more akin to solid metal forging, for example, in the use of vertical forging presses in shaping of the articles." Further, the sentence of column 1 beginning at line 45 of Tausig discusses that thixoforming processes are subdivided based on which conventional metal shaping technology with which they are comparable, especially in terms of the actual machinery that is used for metal shaping. This is in accord with Applicant's argument, that in

thixocasting metal is treated by a molding press, while in thixoforging metal is treated by a forging device.

Turning now to the primarily cited reference to Kruse, the following is noted. Kruse clearly neither discloses nor suggests manufacturing a piston for an internal combustion engine in which a billet is heated to an intermediate temperature between solidus and liquidus temperatures and shaped by thixoforging. Nor is it formed in one piece. Rather, as discussed in column 2, the method of manufacture of Kruse is by forging a one piece piston body; this is followed, however, as described in column 3, by a piston ring belt portion 52 being connected to the head portion 38 and to a flange portion 50 of the piston body 34 by welding, for example.

Thus, Kruse fails to disclose the piston being formed from a metal part cast in one piece, and fails to disclose shaping by thixoforging.

The basic position of the Examiner in making the combination of references in the rejection on pages 2 and 3 of the Office Action is that Tausig and Uggowitzer show that it is old in the engine art to utilize thixoforging to form parts which were previously formed by conventional forging methods. However, neither Tausig nor Uggowitzer motivate one of ordinary skill in the art to make the piston according to the present invention.

Tausig does not relate to the engine art. Tausig does relate to thixoforming generally as a process for producing metal articles. The one example discussed in column 8 of Tausig relates to an automotive clutch hub, but does not relate to an engine or the manufacture of a piston for an engine. There is no disclosure or suggestion of the suitability of the process discussed in Tausig for manufacturing a piston of an internal combustion engine.

Uggowitzer relates to a process for producing a metal alloy material that is capable of thixotropic forming. Again, Uggowitzer does not relate to the engine art. There is no disclosure or suggestion of any suitability for the processes disclosed therein for the manufacture of a piston.

Accordingly, neither Tausig nor Uggowitzer properly suggest to one of ordinary skill in the engine art of manufacturing pistons by the processes disclosed therein. The Examiner's characterization of a clutch hub as an engine part is respectfully submitted to be incorrect. There is no suggestion from either Tausig or Uggowitzer to manufacture a piston for an internal combustion engine according to the methods discussed therein.

Turning back to Uggowitzer, it is noted that it does not describe a thixoforging process. It concerns the field of aluminum and light alloys/metals. See column 1, lines 21-25. Further, it teaches a process for making alloys having thixotropic behavior, noting lines 26-40 of the same column, which makes them usable in a thixotropic forming process such as, but not exclusively, thixoforging. To this end, a globular structure for the metal, instead of a dendritic structure, is obtained by heating the alloy above the liquidus temperature, adding an additive reducing the interfacial surface energy between the liquid and solid phases, and maintaining the alloy in the semi-liquid state, between liquidus and solidus, for fifteen minutes or more. Then, immediately, or later, after a solidification step, forming can be performed.

It is further noted that in Uggowitzer, the use of steel is only considered very briefly in column 8, line 47. There are no details as to what additives or process features would be recommended for the application to steel. No use of this process for thixoforging of pistons of any shape or material is considered. Thus, Uggowitzer would not have been suggested to one of ordinary skill in the art so as to arrive at the present invention as claimed.

Tausig teaches how to obtain a non-dendritic but already globular structure within an alloy so as to optimally use this alloy in a further thixoforming step. Noting the end of column 2 and the beginning of column 3, the process steps are as follows:

1) melting an alloy (so placing it in the liquid state);

2) reducing its temperature to less than 10°C above its liquidus temperature, preferably to 5 or 2°C above the liquidus, or even better exactly at the liquidus temperature (see col. 4, l. 21-31);

3) casting this metal at the temperature into a mold (preferably a steel mold at ambient temperature: col. 5, l. 45-50), then letting the metal cool down to ambient temperature; it contains the globules which are sought for the next step; and

4) heating the metal up to a temperature between solidus and liquidus and thixoforming it by any process, for example by thixocasting in a die.

It should be noted in particular that steps 1-3 of Tausigs' process, as outlined above, are completely absent from the present invention. This is because when the present invention is applied with respect to a ferrous alloy, and in particular carbon steel, such steps of Tausig are not

necessary. Note the original specification of the present application, in particular the last paragraph of page 4 and continuing to page 5, second paragraph, where the preferred globular structure is present during heating before thixoforging if the steel billet was produced by a continuous casting process with electromagnetic stirring during solidification. In such a process, the dendritic solidification structure is at once fragmented, and the final structure is of the equiaxial type in most of the billet. That allows the desired globular structure to be obtained without difficulty during the heating which precedes the thixoforging, without necessarily using a separate heating step. Thus, the process of Tausig is not necessary for making thixoforged steel pistons according to the preferred embodiment of the present invention.

In any case, Tausig provides few details concerning thixoforming itself, and says nothing about making pistons from any material by a thixoforging process.

With respect to considering the possibility of a combination with Tausig to make pistons from steel, it is noted that the process would be impossible to use on steel under industrial conditions. Maintaining a liquid steel melt of a sufficient volume to make pistons at a homogeneous temperature of only some degrees higher than the liquidus is not possible. Note that the example described in column 8, line 29, to column 9, line 34 concerns the production of clutch hubs made of aluminum alloy. These parts are very small, and aluminum has a melting temperature far lower than steel. Accordingly, there is no indication to one of ordinary skill in the art that the process of Tausig would be usable for making steel pistons. It is incidentally noted that clutch hubs are usually made of steel, and it can be questioned why Tausig did not employ steel for making such clutch hubs, especially as it is doubtful that a clutch hub made of aluminum would provide sufficient long term resistance.

Winter is directed to the making of a slurry used for a thixoforming process. However, there is no suggestion of using thixoforging to make pistons, and in particular steel pistons.

In general, then, the secondary references that the Examiner has cited can be said to relate to thixoforming processes. However, they are not specific to the manufacture of pistons and the problems related thereto. Nor are they specifically directed to thixoforging, though thixoforging is discussed therein. As such, it cannot be fairly said that there is any sufficient motivation from these references to specifically adapt thixoforging to the manufacture of pistons based upon the

teachings that are in fact present in the references. At best, it seems that the Examiner's rejection is based on it being obvious to try the process in the secondary references on the primary reference. However, the obvious to try standard has been specifically rejected, noting MPEP §2145(X)(B).

It must be additionally noted that the prior art has recognized no problem that the secondary references are solving. The primary reference to Kruse provides a compact one piece cooled piston, and a method for manufacturing the piston. It is further discussed in Kruse that the method of manufacture can include forging the one piece piston body, and welding at least the piston ring belt portion 52. However, no problems are identified in the patent with respect to this method of manufacture.

Uggowitzer recognizes no particular problem with respect to the method of manufacture of Kruse. The Examiner's rationale is based upon the citation from Uggowitzer in column 1 that forming in a semi-solid state may offer great economic advantages, but this is discussed in the context of forming aluminum or magnesium alloys. There is no indication from Uggowitzer that such economic advantages would be achieved in applying thixoforging specifically to a complicated structure such as in Kruse. Nor is there any indication that such general motivation would be sufficient to suggest to one of ordinary skill in the art that the two could be successfully combined. Nor does this represent any specific suggestion of thixoforging. Nor, in particular, does it represent a suggestion of steel.

There are a number of additional positions taken by the Examiner with respect to what would be considered obvious, an obvious design choice, conventional, etc. It is believed that it is not necessary to specifically address these points at this time, in view of the lack of suggestion contained within the primary and secondary references cited by the Examiner. However, Applicant reserves his right to address such issues at any later point in time as necessary.

It is acknowledged that some of the claims are product-by-process claims, though not all. The structure that results from the steps recited therein is in fact different from that suggested by the prior art; in other words, distinctive structural characteristics result. The point of product-by-process claims is that the distinctive structural characteristics cannot always be made clear by reference thereto; as a result, reference is made to the way in which the structure is formed.

Lastly, concerning the Examiner's comments with respect to JP 2000-186616, it should be noted that the description therein clearly teaches away from the present invention. In JP '616, the mushy metal is <u>injected into a mold</u>, where it is allowed to solidify, and it is not forged in a semi-liquid state as required by the present invention. Further, in the present invention, the heating that precedes the forming step is performed on an already homogeneous solid billet, while in JP '616, the heating is preformed in a mixture of MG chip and fly ash.

In view of the above, it is submitted that the present application is now in condition for allowance, and the Examiner is requested to pass the case to issue. If the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact Applicant's undersigned representative.

Respectfully submitted,

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